

# **International Colloquium on Stability and Ductility of Steel Structures**

**(SDSS'Rio 2010)**

**Rio de Janeiro, Brazil  
8-10 September 2010**

**Volume 1 of 2**

**Editors:**

**Eduardo de M. Batista  
Luciano R. O. de Lima**

**Pedro C. G. da S. Vellasco**

**ISBN: 978-1-62748-704-7**

**Printed from e-media with permission by:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571



**Some format issues inherent in the e-media version may also appear in this print version.**

Copyright© (2010) by COPPE – Federal University of Rio de Janeiro  
All rights reserved.

Printed by Curran Associates, Inc. (2013)

For permission requests, please contact COPPE – Federal University of Rio de Janeiro  
at the address below.

COPPE – Federal University of Rio de Janeiro  
Civil Engineering Program  
c/o Prof. Eduardo Batista  
PO Box 68506 CEP 21941-972  
Rio de Janeiro RJ Brazil

Phone: 55 21 2562 8480  
Fax: 55 21 2562 8484

[batista@coc.ufrj.br](mailto:batista@coc.ufrj.br)

**Additional copies of this publication are available from:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571 USA  
Phone: 845-758-0400  
Fax: 845-758-2634  
Email: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

## CONTENTS

### VOLUME 1

<b>PREFACE</b>	<b>v</b>
<b>1. SDSS HISTORICAL BACKGROUND</b>	<b>1</b>
How all of it started - some reminiscences about the first international colloquia in the stability series <i>M. Škaloud</i>	3
<b>2. KEYNOTE LECTURES</b>	<b>7</b>
Some issues for column stability criteria <i>Reidar Bjorhovde</i>	9
The effect of edge support on tensile membrane action of composite slabs in fire <i>Anthony K. Abu and Ian W. Burgess</i>	21
Latest developments in the GBT analysis of thin-walled steel structures <i>Dinar Camotim, Cilmara Basaglia, Rui Bebiano, Rodrigo Gonçalves and Nuno Silvestre</i>	P 1C
Dual-steel frames for multistory buildings in seismic areas <i>D. Dubina</i>	59
Advanced stability analysis of regular stiffened plates and complex plated elements <i>László G. Vigh and László Dunai</i>	81
Direct strength design of cold-formed sections for shear and combined actions <i>Cao Hung Pham and Gregory J Hancock</i>	101
Manufacturing specifications for hollow sections in 2010 <i>Jeffrey A. Packer</i>	115
Numerical study on stainless steel beam-columns with transverse loading <i>N. Lopes, P. Vila Real and L. Simões da Silva</i>	123
<b>3. BRIDGES AND FOOTBRIDGES</b>	<b>131</b>
Improved cross frame connection details for steel bridges with skewed supports <i>Craig Quadrato, Anthony Battistini, Todd A. Helwig, Karl Frank and Michael Engelhardt</i>	133
Flange thickness transitions of bridge girders-buckling behaviour in global bending <i>A. Lechner, A. Taras and R. Greiner</i>	141
A visco-elastic sandwich solution for orthotropic decks of steel bridges <i>Ronaldo C. Battista, Emerson F. dos Santos, Raimundo Vasconcelos and Michèle S. Pfeil</i>	149

Elegance and economy - a new viaduct over the river Llobregat <i>Peter Tanner, Juan L. Bellod and David Sanz</i>	157
Design of beam-to-beam butt-plate joints in composite bridges <i>A. Lachal, S.S. Kaing and S. Guezouli</i>	165
<b>4. CONNECTIONS</b>	<b>173</b>
Experimental analysis of composite connections using slab made by precast joist with lattice and bricks <i>William Bessa, Roberto M. Gonçalves, Carlo A. Castiglioni and Luis Calado</i>	175
Response of end-plate joints under combined forces <i>N. Baldassino, A. Bignardi and R. Zandonini</i>	183
Influence of member components on the structural performance of beam-to-column joints of pitched roof portal frames with class 3 and 4 sections <i>I. Mircea Cristutiu, Dan Dubina</i>	191
Application of Eurocode 3 to steel connections with four bolts per horizontal row <i>J.-F. Demonceau, K. Weynand, J.-P. Jaspart and C. Müller</i>	199
A new hybrid testing procedure of the low cycle fatigue behaviour for structural elements and connections <i>Carlo Andrea Castiglioni, Alberto Drei and Roberto Goncalves</i>	207
Proposal of a three-dimensional semi-rigid composite joint: tests and finite element models <i>Beatriz Gil, Rufino Goñi and Eduardo Bayo</i>	215
Strength and ductility of bolted T-stub macro-components under monotonic and cyclic loading <i>Nicolae Muntean, Daniel Grecea, Adrian Dogariu and Dan Dubina</i>	223
Prediction of the cyclic behaviour of moment resistant beam-to-column joints of composite structural elements <i>Nauzika Kovács, László Dunai and Luís Calado</i>	231
Numerical modeling of joint ductility in steel and steel-concrete composite frames <i>Leslaw Kwasniewski and Marian Gizejowski</i>	239
Influence of chord axial loading on the stiffness and resistance of welded "T" joints of SHS members <i>Rui M. M. P. de Matos, Luís F. Costa-Neves and Luciano R. O. de Lima</i>	247
Experimental studies of behaviour of composite beam-column flush end plate connections subjected seismic loading <i>Olivia Mirza and Brian Uy</i>	255
Modelling connections of moment resisting steel frames for seismic analysis <i>L. Mota, A. T. da Silva, C. Rebelo, L. Simões da Silva and Luciano R. O. de Lima</i>	263
Influence of local plastic buckling of joint on carrying capacity of a thin-walled truss <i>H. Pasternak, G. Kubieniec and V. Bachmann</i>	271

Numerical analysis of endplate beam-to-column joints under bending and axial force <i>Monique C. Rodrigues, Luciano R. O. de Lima, Sebastião A. L. de Andrade, Pedro C. G. da S. Vellasco and José G. S. da Silva</i>	279
Loss of preload in bolted connections due to embedding and self loosening <i>Roland Friede and Jörg Lange</i>	287
Plastic resistance of L-stubs joints subjected to tensile forces <i>M.Couchaux, I.Ryan and M.Hjiaj</i>	295
Composite beam modelling at real scale including beam-to-beam joint <i>S. Guezouli and A. Lachal</i>	303
Resistance of laser made t RHS joints under compression load <i>Jerzy K. Szlendak</i>	311
Cold-formed steel and concrete composite beams: study of beam-to-column connection and region of hogging bending <i>Mairal R. and Malite M.</i>	319
Shear bolted connections: numerical model for a ductile component, the plate-bolt in bearing <i>J. Henriques, L. Ly, J.-P. Jaspart and L. Simões da Silva</i>	327
<b>5. DYNAMIC BEHAVIOR AND ANALYSIS</b>	<b>335</b>
Considerations on the design, analysis and performances of eccentrically braced composite frames under seismic action <i>Hervé Degée, Nicolas Lebrun and André Plumier</i>	337
Effect of the loading modelling, human heel impact and structural damping on the dynamic response of composite footbridges <i>José Guilherme S. da Silva, Francisco J. da C. P. Soeiro, Pedro C. G. da S. Vellasco, Luciano R. O. de Lima and Nelson L. de A. Lima</i>	345
Structural damage assessment using the differential evolution and the ant colony optimization techniques <i>Genasil F. dos Santos, José Guilherme S. da Silva and Francisco J. da C. P. Soeiro</i>	353
Free and forced nonlinear vibrations of steel frames with semi-rigid connections <i>Andréa R.D. Silva, Ricardo A.M. Silveira, Alexandre S. Galvão and Paulo B. Gonçalves</i>	361
Static and dynamic behavior of lens-type shear panel dampers for highway bridge bearing <i>Tatsumasa Takaku, Feng Chen, Takashi Harada, Masayuki Ishiyama, Nobuhiro Yamazaki, Tetsuhiko Aoki and Yuhshi Fukumoto</i>	369
Elasto-plastic buckling behavior of H-shaped beam with large depth-thickness ratio under cyclic loading <i>Tao Wang and Kikuo Ikarashi</i>	377
Analytical studies of a full-scale steel building shaken to collapse <i>Keh-Chyuan Tsai, Yi-Jer Yu and Yuan-Tao Weng</i>	385

Robustness of steel and composite buildings under impact loading <i>Ludivine Comelieu, Jean-François Demonceau and Jean-Pierre Jaspart</i>	393
Design of steel frames of dissipative shear walls <i>C. Neagu, F. Dinu and D. Dubina</i>	401
Effects of wind on a 3 dimensional steel structure for the central corridor roof (central spine) at TCS campus at Siruseri, Chennai (India) - a case study <i>T. S. Gururaj and Nagaraja M. Thontalapura</i>	409
Influence of system uncertainties on structural damage identification through ambient vibrations of steel structures <i>Leandro Fadel Miguel, Letícia Fadel Miguel, Jorge D. Riera, Marta G. Amani and Raúl O. Curadelli</i>	417
Non-linear dynamic analysis of stayed steel columns <i>Ricardo R. de Araujo, José G. S. da Silva, Pedro C. G. da S. Vellasco, Sebastião A. L. de Andrade, Luciano R. O. de Lima and Luis A. P. Simões da Silva</i>	423
<b>6. FIRE ENGINEERING</b>	<b>431</b>
Interaction diagrams for design of concrete-filled tubular columns under fire <i>Rodrigo B. Caldas, João Batista M. Sousa Jr. and Ricardo H. Fakury</i>	433
Ductility of simple steel connections in fire <i>J. Buick Davison, Ian W. Burgess, Roger J. Plank, Hongxia Yu and Ying Hu</i>	441
Methodology for reliability-based design of steel members exposed to fire <i>Shahid Iqbal and Ronald S. Harichandran</i>	449
Capacity reduction and fire load factors for steel columns exposed to fire <i>Shahid Iqbal and Ronald S. Harichandran</i>	457
Stability of steel columns subjected to fire <i>Markus Knobloch, Diego Somaini, Jacqueline Pauli and Mario Fontana</i>	465
Fire behavior of concrete-filled steel circular hollow section columns with massive steel core <i>Martin Neuenschwander, Markus Knobloch and Mario Fontana</i>	473
Buckling of concrete filled steel hollow columns in case of fire <i>Tiago A. C. Pires, João P. C. Rodrigues and J. Jefferson Régo Silva</i>	481
Buckling of steel and composite steel and concrete columns in case of fire <i>Antonio M. Correia and João Paulo C. Rodrigues</i>	489
A coupled fluid-thermal-mechanical analysis of composite structures under fire conditions <i>Julio Cesar Gonçalves da Silva and Alexandre Landesmann</i>	497
Behaviour of composite floor beam with web openings at high temperatures <i>V.Y. Bernice Wong, Ian W. Burgess and Roger J. Plank</i>	505
To shear resistance of castellated beam exposed to fire <i>F. Wald, A. Pelouchová, J. Chlouba and M. Strejček</i>	513

Numerical analysis of steel columns considering the walls on fire condition <i>Jonas B. Dorr, Jorge M. Neto and Maximiliano Malite</i>	521
---	-----

On the strength and DSM design of cold-formed steel columns failing distortionally under fire conditions <i>Alexandre Landesmann, Dinar Camotim</i>	529
--	-----

## VOLUME 2

<b>7. MEMBERS' BEHAVIOR: TENSION, COMPRESSION, BEAMS, BEAM-COLUMNS</b>	<b>537</b>
The collapse load in submarine pipelines under compressive load and internal pressure <i>Luciano M. Bezerra and Ramon S. Y. C. Silva</i>	539
Stability analysis of 3D frames using a mixed co-rotational formulation <i>Rabe Alsafadie, Mohammed Hjaj and Jean-Marc Battini</i>	547
Plastic collapse mechanisms in compressed elliptical hollow sections <i>Aimar Insausti and Leroy Gardner</i>	555
Collapse of a steel structure as a result of local buckling <i>Heiko Merle and Jörg Lange</i>	563
Strength and ductility of steel beams with flange holes <i>K.S. Sivakumaran, P. Arasaratnam and M. Tait</i>	571
Residual stress measurements in roller bent he 100b sections <i>R.C. Spoorenberg, H.H. Snijder and J.C.D. Hoenderkamp</i>	579
Lateral torsional buckling of space structures with I-beams - structural behavior and calculation <i>Richard Stroetmann</i>	587
Analytical derivation of a generalized-slenderness formula for in-plane beam-column design and comparison with interaction-concept formulae <i>Andreas Taras and Richard Greiner</i>	595
Load bearing capacity of bracing members with almost centric joints <i>Harald Unterweger</i>	603
Finite element modeling of angle bracing member behavior in experimentally tested sub-frame specimens <i>Anna M. Barszcz, Marian A. Gizejowski and Wael A. Salah Khalil</i>	611
Influence of splices on the stability behaviour of columns and frames <i>Pedro D. Simão, Ana M. Girão Coelho and Frans S. K. Bijlaard</i>	619
Further results on the application of the extrapolation techniques <i>Tadeh Zirakian</i>	627
Elastic lateral-distortional buckling of singly symmetric i-beams: the 2005 AISC specification <i>Tadeh Zirakian and Jian Zhang</i>	635

System stability design criteria for aluminum structures <i>Ronald D. Ziemian and J. Randolph Kissell</i>	641
Advanced nonlinear investigations of a 50 m span frame case study: the steel structure of the ice rink, city of Targus-Mureş, Romania <i>Zsolt Nagy and I. Mircea Cristutiu</i>	649
Local post-buckling behaviour of elliptical tubes <i>Nuno Silvestre and Leroy Gardner</i>	657
Plastic design of stainless steel structures <i>Marios Theofanous and Leroy Gardner</i>	665
Inelastic behaviour of partially restrained steel frames <i>Renata G. L. da Silva and Armando C. C. Lavall</i>	673
Robust design – alternate load path method as design strategy <i>Lars Roelle and Ulrike Kuhlmann</i>	681
Use of eigenvalue analysis for different levels of stability design <i>Jozsef Szalai</i>	689
The non-destructive measurement of residual stresses in stainless steel roll formed sections <i>Rachel B. Cruise and Anna M. Paradowska</i>	697
Influence of flange-to-web connection on the patch load resistance of I beams <i>László G. Vigh</i>	705
Further studies on the lateral-torsional buckling of steel web-tapered beam-columns: analytical studies <i>Gabriel A Jimenez</i>	713
Lateral buckling of continuous steel beams with hinges <i>Peter Osterrieder, Stefan Richter and Matthias Friedrich</i>	721
<b>8. PLATED STRUCTURES AND BOX GIRDERS</b>	<b>729</b>
The interaction behaviour of steel plated structures under transverse loading, bending moment and shear force <i>Benjamin Braun and Ulrike Kuhlmann</i>	731
Hybrid steel plate girders subjected to patch loading <i>Rolando Chacon, Enrique Mirambell and Esther Real</i>	739
Numerical and experimental research in tapered steel plate girders subjected to shear <i>E. Real, A. Bedynek and E. Mirambell</i>	747
Shear strength of steel plates with reinforced opening <i>Bo Chen and K.S. Sivakumaran</i>	755
Crack initiation under static loads including the influence of residual welding stresses <i>Michael Volz and Helmut Saal</i>	763

The fatigue and serviceability limit states of the webs of steel girders subjected to repeated loading <i>M. Škaloud and M. Zörnerová</i>	771
Imperfections in steel plated structures and their impact on ultimate strength <i>J.Kala, M.Škaloud, J.Melcher and Z.Kala</i>	779
Imperfection sensitivity analysis of longitudinally stiffened plated girders subjected to bending-shear interaction <i>F. Sinur and D. Beg</i>	787
<b>9. SHELLS</b>	<b>795</b>
Influence of geometry on the dynamic buckling and bifurcations of cylindrical shells <i>Zenon N. del Prado and Paulo B. Gonçalves</i>	797
Buckling of a shallow rectangular bimetallic shell subjected to outer loads and temperature <i>M. Jakomin and F. Kosel</i>	805
A geometry based method for the stability analysis of plates <i>Hesham Ahmed, John Durodola and Robert G. Beale</i>	813
Critical loads and stability of an open elastic-plastic cylindrical shell with the core of variable stiffness <i>Jerzy Zielnica</i>	821
<b>10. STEEL-CONCRETE COMPOSITE MEMBERS AND STRUCTURES</b>	<b>829</b>
Ductile response of composite steel and concrete frames <i>Luigi Di Sarno</i>	831
Stability and ductility of castellated composite beams subjected to hogging bending <i>Marian A. Gizejowski and Wael A. Salah Khalil</i>	839
Shear connection in steel and concrete composite trusses <i>Josef Machacek and Martin Cudejko</i>	847
Steel and concrete composite building structures – an economical approach <i>Catarina Costa, Luís F. Costa-Neves and Luciano R. O. de Lima</i>	855
Behavior of steel-concrete composite beams with flexible shear connectors <i>Gilson Queiroz, Francisco C. Rodrigues, Sebastião S. Pereira, Michèle S. Pfeil, Cláudia G. Oliveira and Luciene A. C. da Mata</i>	863
Influence of the friction at the support in the longitudinal shear strength of composite slab <i>A. C. C. Lavall, R. S. Costa and F. C. Rodrigues</i>	871
A parametric analysis of composite beams with t-perfobond shear connectors <i>Juliana da C. Vianna, Sebastião A. L. de Andrade, Pedro C. G. da S. Vellasco and Luís F. da C. Neves</i>	879

FE modelling of slender concrete-filled stainless steel tubular columns under axial compression <i>Zhong Tao, Brian Uy and Lin-Hai Han</i>	887
Buckling resistance of steel-concrete columns composed of high-strength materials <i>Marcela Karmazinová and Jindrich J. Melcher</i>	895
<b>11. THIN-WALLED CONSTRUCTION AND COLD-FORMED MEMBERS</b>	<b>903</b>
Effects of distortion on the shear stiffness of rack structures <i>Sambasiva R. Sajja, Robert G. Beale and Michael H.R. Godley</i>	905
Buckling, post-buckling, collapse and design of two-span cold-formed steel beams <i>Cilmar Basaglia and Dinar Camotim</i>	913
Experimental and numerical investigation of polyurethane sandwich panels <i>I. Vayas, M.-E. Dasiou and X. A. Lignos</i>	921
Imperfections' sensitivity analysis of pitched roof cold-formed steel portal frames <i>Dan Dubina, Viorel Ungureanu, Zsolt Nagy, Luis Nunes and Paul Pernes</i>	929
Ultimate limit strength of perforated cold-formed steels sections <i>Andrei Crisan, Viorel Ungureanu and Dan Dubina</i>	937
On the use of cold-formed thin walled members for vertical addition of existing masonry buildings <i>G. Di Lorenzo, A. Formisano, R. Landolfo, F. M. Mazzolani and G. Terracciano</i>	945
Theoretical analysis of perforated rack columns <i>Arlene M. S. Freitas, Marcílio S. R. Freitas and Flávio T. Souza</i>	953
Optimization of cold-formed steel channel using the direct strength method and finite strip method <i>Gladimir de Campos Grigoletti, Ignacio Iturrioz, Gustavo Mezzomo and Zacarias Martin Chamberlain Pravia</i>	961
Experimental investigation of high strength cold-formed supacee sections in shear <i>Cao Hung Pham and Gregory J. Hancock</i>	969
Effective design of cold-formed thin-walled channel beams with bent edges of flanges <i>Ewa Magnucka-Blandzi and Krzysztof Magnucki</i>	977
Lateral buckling of steel sigma-cross-section beams with web holes <i>Jindrich J. Melcher and Marcela Karmazinová</i>	985
Load-bearing capacity of perforated trapezoidal sheeting <i>Thomas Misiek and Helmut Saal</i>	993
Trapezoidal sheeting made of stainless steel – two amendments to complete the design codes <i>Thomas Misiek, Helmut Krieger, Karsten Kathage and Thomas Ummenhofer</i>	1001
Pull-trough resistance of tensile-loaded screw-fastenings of thin-walled sheeting and sandwich panels <i>Thomas Misiek, Saskia Käpplein and Karsten Kathage</i>	1009

---

The cold work of forming effect in steel structural members <i>Tian Gao and Christopher D. Moen</i>	1017
Finite element analysis of high strength cold-formed supacee sections in shear <i>Cao Hung Pham and Gregory J. Hancock</i>	1025
Classification of stability failure modes of sandwich panels under compression loading: global and local buckling, crippling at support line <i>Saskia Käpplein and Thomas Ummenhofer</i>	1033
Strength estimation of end failures in corrugated steel shear diaphragms <i>Nobutaka Shimizu and Kikuo Ikarashi</i>	1043
Plate buckling according to Eurocode 3. Comparison of the effective width method and the reduced stress method <i>Jose M. Simon-Talero and Ana Caballero</i>	1051
DSM design of lipped channel columns undergoing local/distortional/ global mode interaction <i>Nuno Silvestre, Pedro B. Dinis, Dinar Camotim and Eduardo M. Batista</i>	1061
Bracing stiffness and strength in sheathed cold-formed steel stud walls <i>Luiz C. M. Vieira Jr. and Benjamin W. Schafer</i>	1069
Shear behaviour of trapezoidal sheeting without shear panel construction <i>J. Lindner and F. Seidel</i>	1077
Thin beam static stability analysis by an improved numerical method <i>A. Khelil</i>	1085
Investigation of the test method for distortional buckling of compressed pallet rack members <i>Miquel Casafont, Magdalena Pastor, Francesc Roure and Teoman Peköz</i>	1093
Behaviour of expanded metal panels under shear loading <i>Phung Ngoc Dung and André Plumier</i>	1101
Analysis of contact buckling in built-up cold-formed steel beams assembled by laser welding <i>F. Portioli, O. Mammana, G. Di Lorenzo and R. Landolfo</i>	1109
Cross-sectional stability of structural steel <i>Mina S. Seif and Benjamin W. Schafer</i>	1117
Influence of holes on the behaviour of cold-formed steel sections under compression <i>M.M. Pastor, M. Casafont, F. Roure, J. Bonada and J. Noguera</i>	1125
Applications of pure and combined buckling mode calculation of thin-walled members using the finite element method <i>Gustavo P. Mezzomo, Ignacio Iturrioz and Gladimir de C. Grigoletti</i>	1133
Post-buckling behaviour and strength of angle columns <i>Pedro B. Dinis, Dinar Camotim and Nuno Silvestre</i>	1141
Experimental study on cold-formed steel lipped channel columns undergoing local-distortional-global interaction <i>Eliane S. Santos, Eduardo M. Batista and Dinar Camotim</i>	1151

<b>12. TRUSSES, TOWERS AND MASTS</b>	<b>1159</b>
Stability bracing requirements of trusses <i>Rangsan Wongjeeraphat and Todd A. Helwig</i>	1161
Theoretical and experimental analysis of steel space-truss with stamped connection <i>Cleirton A. S. Freitas, Luciano M. Bezerra and Ramon S. Y. Silva</i>	1169
Real scale experimental analyses of circular hollow section multi-planar steel trusses <i>Rodrigo C. Vieira, João A. V. Requena, Newton de O. P. Junior and Afonso H. M. de Araújo</i>	1177
Natural period of steel chimneys <i>Aleksander Kozłowski, Andrzej Wojnar and Leonard Ziemiąński</i>	1185
Dynamic response of conical and spherical shell structures subjected to blast pressure <i>Tomasz Kubiak, Zbigniew Kolakowski, Katarzyna Kowal-Michalska, Radosław Mania and Jacek Swiniarski</i>	1193

**AUTHOR INDEX**

Volume 1

Volume 2